effectually prevents any hernia-like outpushing of the abdominal cavity backwards. There is thus an important difference between the species with which I am now concerned and that which formed the subject of my earlier paper.

With reference to the latter species, I am able, through the kindness of Mr. R. H. Burne, to submit a drawing of a dissection made by that anatomist on a specimen of the toad which I presented to the Royal College of Surgeons. Having also seen the actual dissection, I am obliged to admit that Mr. Burne has proved that my former account of this region of the body was not correct in every detail. Mr. Burne has ascertained and has demonstrated to me that the structure which I termed a "lymph heart" is a diverticulum of the body-cavity, lying, however, on the leg, as is clearly shown in the accompanying drawing (text-fig. 133, p. 411). This connection was so wide that the bladder had floated into the diverticulum.

I feel convinced, however, that the communication was not so wide in the larger female example dissected and figured by myself. For the diverticulum was easily detached from the surrounding structures, a fact which argues some independence, as it would seem at least to show that the orifice into the general thoraco-abdominal cavity can contract. Furthermore, the arrangement of the oblique muscles in the region is rather different from what may be seen anteriorly. Thus we have, certainly in this species, a specialized portion of the thoraco-abdominal cavity (which is recognisable, but much less prominent, in *Breviceps gibbosus*) extending over the dorsal surface of the thigh. It is not, however, I now admit, possible, in the present state of our knowledge, to speak of this as a "lymph heart." I propose, however, to defer any further consideration of this subject until more facts have been accumulated.

21. On the Spermatophores in Earthworms of the Genus *Pheretima* (= *Perichæta*). By Frank E. Beddard, M.A., F.R.S., F.Z.S., Prosector to the Society.

[Received December 28, 1910: Read March 7, 1911.]

(Text-figures 134–136.)

I believe that there is no account of the spermatophores in this genus of Earthworms; and at least there has not been, to my knowledge, anything more than the briefest reference to their occurrence. It might be expected from analogy that this genus, like so many others, possessed this means of impregnation; but I can recall no figures of such structures. Even supposing that I have involuntarily ignored such an account, it is worth while to add something more to the subject, which cannot be well known.

I have lately examined, and shall shortly report upon, a collection of terrestrial Oligochæta from the Philippine Islands, the opportunity of examining which I owe to the kindness of the Director of the Scientific Bureau of the Philippines. I found these structures in two species contained in that collection, one of which I propose to describe as a new species, and the other of which is, as I believe, identical with *Pheretima montana*.

In the first-named species, which is very close to that which I call, in my revision of the genus*, *P. cingulata*, there are four pairs of spermathecæ. In all of these, in individuals which I examined for the present purpose, I found spermatophores, but only one or two in each pouch. They are oval bodies with a long spout-like projection, like a pear with a long stalk. It appeared to me, on examining these mounted in glycerine entire, that the prolongation did not open on to the exterior, and that the sperm had therefore no obvious means of escaping from the case which contains it. If my observations are correct, they do not, as will appear shortly, imply anything anomalous; for the sperm has another way of escape. In the species which I identify with *P. montana* there is only a single pair of spermathecæ. But in each spermatheca was a much larger number of spermatophores. There is an obvious relation here between the total number of spermatophores in the two species. In the former species, moreover, the spermatophores had a longer spout-like projection than in *P. montana*.

The accompanying figure (text-fig. 134, p. 414) illustrates a spermatheca of *P. montana*, cut open and still containing two of the spermatophores, while two others lie in the vicinity. There are also three other spermatophores in this particular spermatheca, making a total of seven. In other cases I have noticed the same, or nearly the same, number of these bodies. The figure referred to shows the shape of the spermatophores quite well. They vary slightly in size, being not more than a millimetre in length, and are spherical to oval with a narrow duct-like prolongation. The shape, in fact, is quite consistent with the view that they are spermatophores. They do not, however, agree absolutely in their form with those of any Annelid which has been up to the present described. In view of the considerable differences which spermatophores show in different genera and families of Oligochæta, this would hardly be expected. On the whole it appears to me that they most resemble those of *Pareudrilus*, described by myself† and Cognetti de Martiis‡.

The spermatophores when viewed with the naked eye or with a hand-lens have a glistening white appearance, which is explained by their minute structure, as will be apparent later. I did not

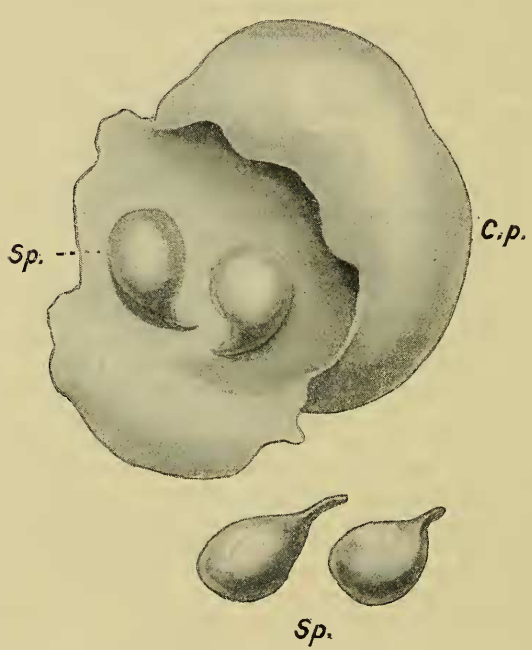
* "A Revision of the Genus *Amyntas*," P. Z. S. 1900, p. 609.

† "On a new Genus and two new Species of Earthworms, &c.," P. Z. S. 1903, p. 210.

‡ "Contributo alla Conoscenza della fecondazione negli Oligocheti," Atti Acc. Sci. Torino, xlv. 1910.

observe any case where the spermatophores were sticking on to the surface of the body of the worm, as they do in the Lumbricidæ, in *Alma*, in *Bothrioneuron*, and among the Leeches. The fact that so many were crowded together in one spermatheca in the species figured here seems to be some evidence in favour of regarding the spermathecæ as *not* being their place of origin. There are also some other facts which favour the same negative supposition. The size of these bodies is small; and it seems difficult to imagine that they could be moulded in the spermathecæ, which are comparatively so large. It might be held, indeed, that the narrow spout in which the spermatophore ends was moulded by the compressed duct of the spermatheca; but this leaves the larger body of the spermatophore unaccounted for.

Text-fig. 134.



Spermatheca (*C.p.*) of *Pheretima montana* containing spermatophores (*Sp.*).

I believe that I showed some reason for regarding the spermatophores of *Benhamia austeni** as entirely formed in the spermatheca and its appendage. But it is equally or perhaps more certain that in other species of Oligochæta the spermatophores are moulded in the glands appended to the male ejaculatory

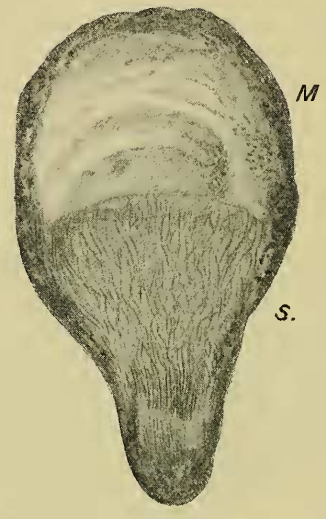
* "On the Spermatophores in the Genus *Benhamia*," P. Z. S. 1901, p. 704

apparatus. Although one might suppose that in two genera, which are probably to be regarded as nearly akin, the formation of the spermatophores would be identical, there is in the *Pheretima* now under consideration some positive evidence to show that the spermatophores are formed in the terminal sac of the male ejaculatory apparatus. In this species, as in other Pheretimas, the spermiducal gland ends in a narrow muscular duct which appears to open into a wide terminal bursa copulatrix. The latter, of course, opens on to the eighteenth segment by a conspicuous orifice. When sections are made through this terminal apparatus it is seen that the cavity of the bursa copulatrix is by no means so large as the peripheral measurements of the sac would lead one to imagine, but that the greater part of its cavity is occupied by a large penis, which can doubtless be protruded. This penis, which is of a conical form, is surrounded by the cavity of the bursa, which, however, lies chiefly to one side, and there is in that region, therefore, a space of moderate dimensions which is not far from the size of one of the spermatophores. Furthermore, the cells which line this cavity, except near to its external orifice, are tall, and the glandular-looking cells stain badly, and thus appear to be full of some hardly stainable secretion. The muscular duct leading from the spermiducal gland is joined at about the end of the first fourth of the penis by the sperm-duct (here single and apparently not ciliated), and the conjoined duct opens not on to the end of the penis, but rather to the side, *i. e.* inside the cavity of the bursa copulatrix, so that it might inject the sperm into the cavity of the bursa. This sperm might then be surrounded by an excretion of the glandular cells of the bursa, and thus emerge a complete and fully charged spermatophore. This is admittedly a mere suggestion, and is far from being a conclusive statement. I have, however, no further evidence.

Reverting to the spermatophores themselves, they show, when examined entire with a low power of the microscope, an opaque appearance, less marked naturally at the free tail-like termination. The opacity is doubtless responsible for the white appearance of the body, and is very different from what one would expect in a spermatophore. Presumably with chitinous walls it would be supposed that it would present a transparent, or at least translucent, appearance when examined by transmitted light. This is, however, not the case at all. Moreover the walls of the spermatophore have not a regular outline, but are roughened, as if many minute particles were adherent to the outside. This is not in any way different when the bodies are examined in glycerine. The roughened and opaque exterior prevents a clear view of the contained sperm, and, indeed, it would be impossible to state from such an examination only that there was any sperm within. Viewed in its entirety in glycerine not much more is to be learnt about the spermatophore than is taught by an examination of it as an opaque object with a lens. I have,

however, studied these bodies by the section method, which has allowed me to describe a good many facts concerning their structure, though something remains to be discovered, as will in due course be pointed out. The wall of the spermatophore is the first part of the structure which calls for attention. This is of some thickness, as is shown in the accompanying figure (text-fig. 135); but it is not thicker than that of other spermatophores. Its structure, however, is remarkable, and in some respects unique, at any rate at first sight. The minute structure of the

Text-fig. 135.



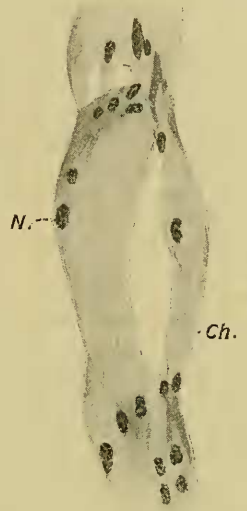
Longitudinal section through spermatophore of *Pheretima montana*.

S. Spermatozoa massed at apical end of case.
M. Mucous and granular substance filling up blind end of case.

wall is illustrated in the accompanying figure (text-fig. 136). At first sight, the wall of the spermatophore suggests a living tissue allied to connective tissue or even muscle. We recognise many nuclei, which occur outside, inside, or within the wall itself. These nuclei are not in any way degenerate structures, and their varying position shows that they are not merely fragments adherent to a sticky structureless wall. For they lie within as well as on both sides of it. In addition to these cells there is a structureless substance which in parts has a fibrillar character. The likeness to muscle is thereby much enhanced. It occurred to me at first that the wall might be actually an adventitious sheath formed by the tissues of the worm's body, and comparable to the sheaths found round foreign bodies when introduced from the outside, or

to the "paruterine organs" of Tapeworms. It may be that this interpretation is correct. But I do not myself hold this view for other reasons, which will be explained. That portion of the wall of the spermatophore which is lettered "*Ch*" in text-fig. 136 seems to me to give the clue to the real nature of the wall. It will be noted that we have a thickish and structureless layer which is surrounded on both sides by cells. The clear layer is not much stained by the carmine, and is quite reasonably to be regarded as the actual unaltered structureless wall of the

Text-fig. 136.



Transverse section through wall of spermatophore of *Pheretima montana* much more highly magnified than in text-fig. 135.

Ch. Chitinous layer. *N*. Nuclei of phagocytes (?).

spermatophore, probably of chitinous nature. Elsewhere the same structureless substance is found which shows evidence of being hollowed out. These facts thus briefly stated lead me to the inference that we have here a spermatophore in which the original chitinous wall is being gradually eaten away by leucocytes. I do not see any other view which fits in so well with both fact and probability.

Indeed, the only other interpretation of the histological facts, which is not very much borne out by the relations of the cells to the membrane, is to suppose that the case of the spermatophore is built round a mass of sperm lying in the spermatheca, a suggestion which, apart from the actual facts, is not at all probable. I feel

fairly confident that the phagocyte theory is the correct one to explain the anomalous appearances seen in the case of the spermatophores of this *Pheretima*. As to the origin of the phagocytes, I have no facts to offer. This is, however, not a weak point in the argument that they are phagocytes. The cells are as cells small; the nucleus is very large compared with its surrounding protoplasm. But the immense numbers of the cells makes up for the lack of non-nuclear protoplasm, and the large nuclei are an indication of their activity. The presence of these cells leads to the rapid and dark staining of the spermatophores, which is very noticeable, and not what would be expected in such a structure, on the view that its walls were entirely chitinous. I obtained the clue to the nature of the processes going on in the spermatophores of this Oligochæte when within the spermatheca by a consideration of an important recently published paper by Dr. Cognetti de Martiis. The author promises a further contribution on the rôle played by phagocytes in the destruction of superfluous spermatozoa; but this memoir I have not yet seen. In the memoir which I have read and the title of which is quoted below *, Dr. de Martiis observed that the spermatozoa leave the large spermatophore, and suggests that the fibrils of the wall of the latter are caused to diverge, and thus leave room for the exit of the spermatozoa, by the action of certain cells against which the end of the spermatophore is pressed, and which form part of the lining epithelium of the spermathecal sac. A chemotactic influence leads on the spermatozoa from cell to cell until they reach the egg-sacs. He thinks that the weak and dying spermatozoa are devoured by phagocytes, and has figured spermatozoa in the interior of phagocytes. This, however, is a quite different series of events from what takes place, as I believe, in *Pheretima*. Here, I repeat, there is some evidence for regarding the phagocytosis of the walls of the spermatophore as a means of liberating the enclosed sperm.

The contents of the spermatophore now demand attention. The cavity of the spermatophore is not entirely filled with spermatozoa. As will be seen in text-fig. 135, the mass of spermatozoa is limited to the lower half of the spermatophore. It occupies hardly half of the whole space available. The mass of spermatozoa is strictly delimited above, and the line of demarcation is a regularly curved line. I think it possible to detect a delicate membrane surrounding the mass of spermatozoa and to be distinguished from the substance to be shortly described which fills up the rest of the cavity of the spermatophore. The inclusion of the spermatozoa in a case independent of the case of the spermatophore itself, and lying within it, is a fact of likeness to the spermatophores of *Benhamia* †, where something of the same kind occurs. It is possible also that the delicate case of the spermatozoa is fabricated in the appendix of the spermatheca.

* "Contributo alla Conoscenza della fecondazione negli Oligochcti," Atti Acc. Sci. Torino, xlv. 1910.

† P. Z. S. 1901.

But if this be so, the whole question of the place of formation of the spermatophore will have to be reconsidered. I have, indeed, no positive facts concerning the reasons for the rounded outline of the mass of spermatozoa.

The arrangment of the spermatozoa requires some description. They are not massed higgledy-piggledy with the heads and the tails pointing in any direction; the arrangement is a perfectly regular one. The heads of the spermatozoa are all on that side of the sperm-mass which is nearest to the "stalk" of the spermatophore. The upper part of the sperm-ball is composed entirely of the tails, which are not disposed in straight lines, but are waved and curved in every direction. The heads radiate outwards in a quadrant or a little more perhaps. The actual heads are in close contact with the walls of the spermatophore, and some of them descend for a space into the narrow duct of that organ. This rather looks as if they were so disposed for easy egress at the time when the sperm has to leave the spermatophore, which suggests that the phagocytosis of the case is not a necessity for fertilisation. It may be also that the spermatozoa escape, as Cognetti de Martiis thought of the spermatozoa of *Pareudrilus pallidus*, through the actual membrane of the spermatophore case, the action of the phagocytes facilitating their egress by widening the strands of the wall.

In any case the fan-like radiation of the heads of the spermatozoa agrees with the idea that those which are more laterally placed, and do not face the external spout-like orifice of the case, may make their way out through the actual walls.

In addition to the spermatozoa the spermatophore contains a granular mass which fills up the available space above the delicate case containing the spermatozoa. This granular mass has the appearace of broken-down cells. A comparison at once suggested itself with the granular substance described by Whitman in the spermatophores of *Clepsine**. In the Leech, however, the granular contents of the spermatophore lie near to the external orifice of the spermatophore, and seem to clear the way from in front of the subsequently issuing spermatozoa, or to perform other functions which are discussed by Whitman. Like Whitman, I was first disposed to regard the granular contents of the spermatophore of *Pheretima* as being of a cellular nature. I believe, however, that the substance is not composed of cells, though probably of broken-down cells.

The position of this granular mass at the apex of the spermatophore suggests that it may be of mechanical assistance† in expelling the sperm, supposing that the latter is usually expelled through the mouth of the spermatophore, and not liberated by

* Journ. Morph. vol. iv. p. 361.

† See also Brumpt, "Reproduction des Hirudinées," Mém. Soc. Zool. France, 1900, p. 286. But Kovalevsky (Comptes Rendus, vol. cxxix. 1899, p. 261) did find cells which he regarded as phagocytes to eat the spermatozoa.

the eating away of the case. Furthermore, if the case be watertight, the presence of this possibly largely fluid mass may be advantageous to the spermatozoa, especially if their sojourn in the spermatophore be long. Its function may be to keep the sperm moist and active. This is, however, mere supposition, and so little is known about the processes of fertilisation in the Oligochæta that no safe guess can be hazarded. But it seems clear from the large mass of granular substance that it plays some important function in fertilisation.

22. A Rare Beaked Whale.

By R. Lydekker.

[Received December 19, 1910: Read March 7, 1911.]

(Text-figures 137–139.)

Some months ago—I believe early in the present year—a Beaked Whale was stranded on the beach near Port Elizabeth, which fortunately came under the notice of Mr. F. W. FitzSimons, the Director of the Museum in that city. Photographs were taken of the specimen as it lay, and the skeleton was subsequently cleaned and placed on exhibition in the Museum. As it lay, the specimen measured $15\frac{1}{2}$ feet in length, from the tip of the muzzle to the end

Text-fig. 137.

Mesoplodon (*Dioplodon*) *grayi* as it lay on the beach.
The back-fin had been hacked by natives.

of the flukes. In colour it was jet-black all over; and the flukes was remarkable on account of the posterior border being convex, instead of deeply emarginate, as in ordinary cetaceans. The skull, of which Mr. FitzSimons forwarded the two photographs herewith reproduced, indicates that the specimen is referable to the genus *Mesoplodon* (as commonly understood); this being manifest from